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The Alteration of Cultivated Rice in Thailand and Cambodia

by

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Rice (*Oryza sativa* L.) has been, in its long process of cultivation, differentiated into several types and varieties with different characteristics. They are, for instance, lowland rice and upland rice, ordinary (non-glutinous) rice and glutinous rice. Differentiation of such ecospecies or ecotypes as the so-called *indica* and *japonica* is also noticed. It is yet to be determined, however, in what sequence they were grown and altered in South and Southeast Asia, the region which is thought to have a close relation with the origin of cultivated rice.

In approaching this problem, the authors paid attention to the existence of rice husk contained in bricks, traditional building materials for temples and city-walls. It is well known that, in some parts of South and Southeast Asia, a considerable amount of rice husks is customarily mixed with clay-soil when the latter is kneaded for shaping bricks.

In their field trip to Thailand in 1967, the authors made a preliminary collection of the bricks out of historical sites located in the Mae Nam Chao Phraya basin. The ruins from which bricks were taken were identified to have been built during the sixth to the eighteenth centuries. The husks contained in the bricks were carefully recovered and compared morphologically. In their interim report (Watabe and Akihama: 1968), the authors maintained that, assuming the date of the husk to be identical with that of the enclosing brick, the husk could be used as indices by which the type of rice then cultivated in the region could eventually be identified. Thus, the authors were able to foresee that a comparison of the reclaimed husk would enable them to infer the process of alteration of dominant types of cultivated rice in the region.

Probably the earliest report on the discovery of rice husk enclosed in an old brick is the report by Ting Ying (1959). The brick which he found at Hupei in China is attributed to the age about 4,000 years b.p., although in South and Southeast Asia, the first use of brick for construction is generally thought to date back not long before

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the beginning of the Christian Era. In the Indochinese peninsula, there exists few edifices of brick prior to the 5th to 6th century, with the notable exception of Oc-Eo. The proposed method, therefore, suffers from a limit in its scope for the purpose of tracing a long history of cultivated rice. The authors believe, however, that knowledge of the changing process of cultivated rice even for such a limited span of time as 1,500 or 2,000 years is a step further toward the eventual determination of the origin of rice. The authors intend to apply the proposed method for investigating the process of change of cultivated rice all over South and Southeast Asia.¹⁾ The present paper constitutes part of such a study, covering Thailand and a part of Cambodia. As for Thailand, for which a preliminary report was made, some corrections are proposed in this paper.

I Material and Method

Sample bricks for the present investigation are those which were collected, one for each place, from 108 archaeological sites in Thailand, 22 pieces in 1967 and 86 pieces in 1968 and those from 8 different sites in Cambodia. Among the samples from Thailand, 76 pieces contained a considerable amount of husks as is shown in the photograph, 24 pieces contained a small amount only and the rest contained none. As for the samples from Cambodia, only two contained a few husks and nil in the rest.

Based upon the estimated ages of the archaeological sites from which the bricks were taken, the authors infer that the bricks sampled were produced during the 6th to 19th century. In determining the dates, reference was made to several specialists of the Fine Arts Department and its provincial branches for whose generous and thoughtful assistance cordial thanks should be accorded. Historical literatures were also consulted whenever applica-

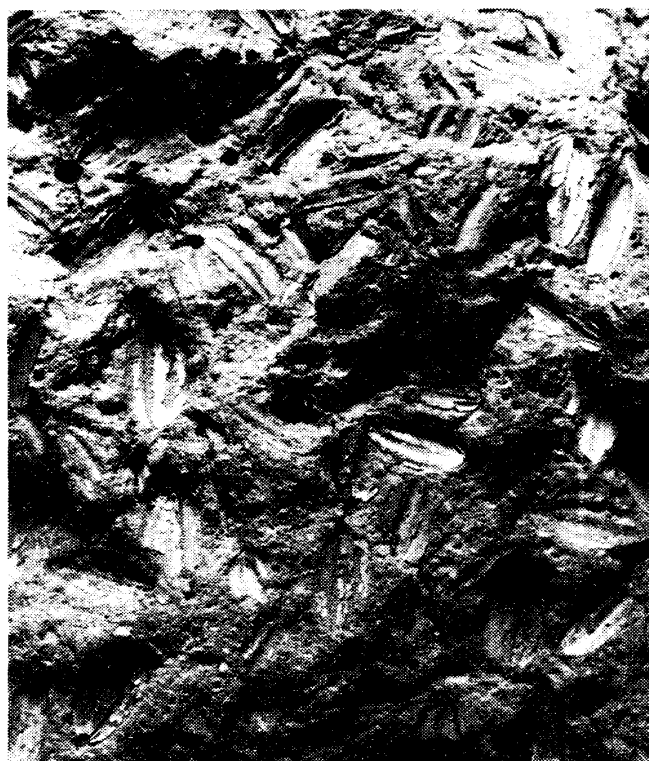


Photo. Rice husks contained in a brick
(T68-11) $\times 1.5$

1) The practice of mixing rice husks with clay soil for making bricks is, to the knowledge of the authors, seen in Thailand, Laos, Burma, South China and a part of India.

ble. As for some unidentifiable places, ^{14}C dating methods were applied to wooden pieces recovered from the same building structure from which the sample bricks were taken. In cases when accurate dating was unobtainable by either of these methods, the samples were excluded from the present investigation. Thus 104 brick samples as shown in Appendix, were finally selected for examination. They were derived from almost all parts of Thailand. As for Cambodia, they were restricted to Battambang and Siemreap.²⁾

The measurement of grain length and breadth were made for selected husks of good shape³⁾, which were grouped into round, large and slender types, each corresponding to a-type (*japonica*), b-type (intermediate type) and c-type (*indica*) respectively in Matsuo's tripartite classification of grain types (Matsuo: 1952). Most bricks contain a single type husk but some comprise two or more different types as is shown in Fig. 1.

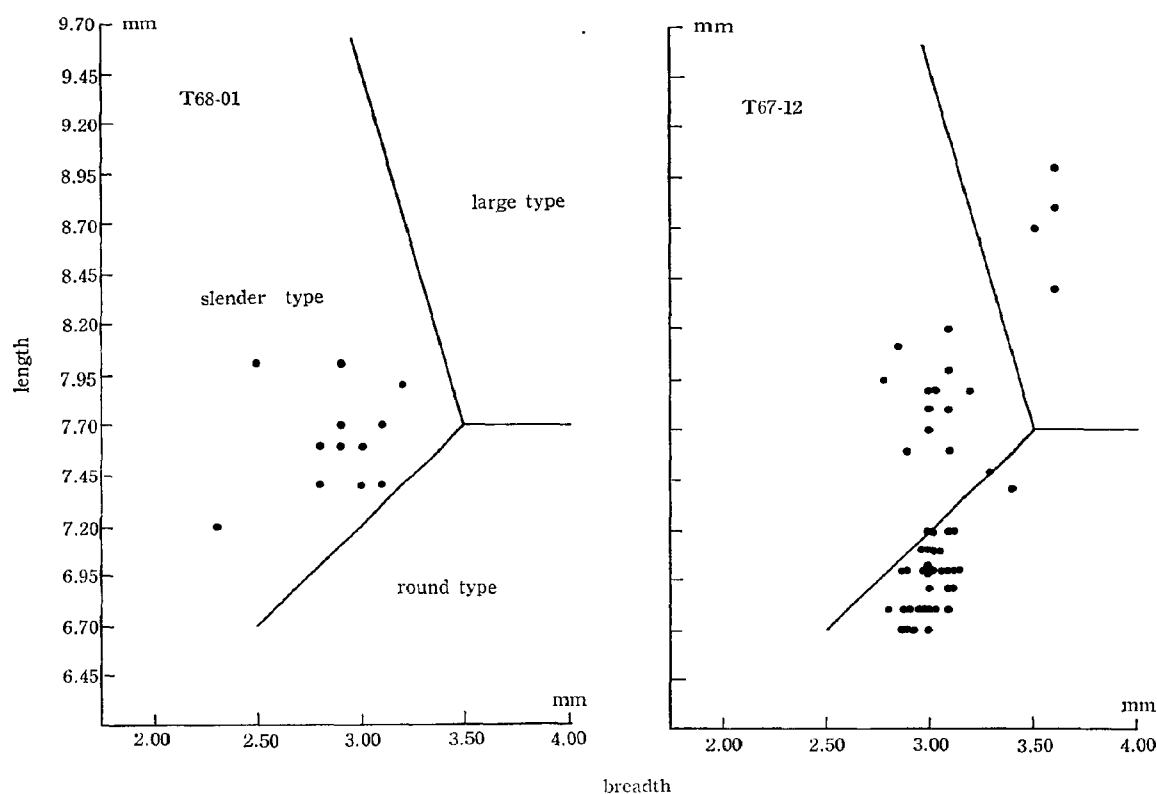


Fig. 1 Grouping of grains enclosed in bricks, according to tripartite classification by Matsuo

- 2) The reclaimed rice husks would most probably be those of the rice grown in areas adjacent to the sampling sites. It is to be kept in mind that a considerable amount of used brick were sometimes brought from one place to another for construction as is recorded in the chronicle of the First Reign of the Bangkok Dynasty (Ishii: 1968). In the present study, bricks of this sort of ambiguous origin were excluded from the examination.
- 3) Bricks are dried for hardening either in the sun (adobe) or in fire. In the latter's case, the authors' experiment indicates that rice husks are contracted in the process of baking by 0.6% to 0.7% in length and by 1.5% in width. This contraction is, however, negligible in the morphological identification of rice type for the present study.

The latter may reflect a situation in which two or more types of rice were grown in a region.

II Results and Discussion

1. Chronological distribution of grain types:

We have divided the span of time which is supposedly covered by the brick samples into the following four periods; (i) 6th–11th centuries, (ii) 11th–15th centuries, (iii) 15th–18th centuries and (iv) after 18th century. Fig. 2 shows a chronological distribution of round, slender and large types mentioned above.

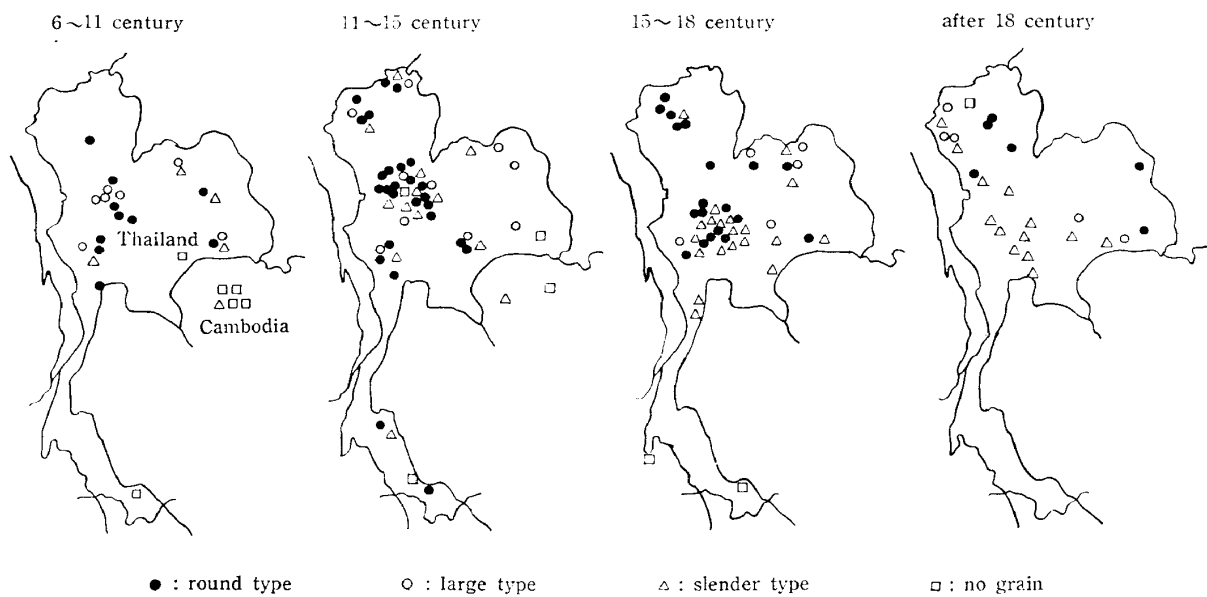


Fig. 2 Chronological distribution of round, large and slender types of grain

It is clearly seen that prior to the 11th century in Thailand most dominant is the round type to be followed in number by the large type. The slender type is distributed mainly in the northeast and Cambodia. It should be noticed in this connection that no slender type is found in the Mae Nam Chao Phraya basin in this period. Bricks without husk are found in Cambodia, the Thailand-Cambodia border area (Buriram) and southern Thailand. In the period from the 11th to 15th centuries in Thailand, the round type continues to be dominant as in the preceding period but a relative increase of the slender type becomes conspicuous all over the country. This tendency goes along with the relative decrease of the large type. In Cambodia, no change is noticeable. In the following period, the 15th to 18th centuries, the round type still prevails extensively, whereas the slender type abruptly increases especially in the Central Plain of Thailand.⁴⁾ This is accompanied by the further decrease of the large type. After

4) The authors have reported in the previous paper that the slender type is dominant in Thailand today. Sakaguchi and Tea (1969) reported that in Cambodia the most dominant variety is of slender type.

the 18th century the slender type becomes extremely prevalent and in the Central Plain this type is grown almost exclusively. In this period, the round and large types are distributed only in the northern and northeastern region.

2. Alteration and characteristics of grain types:

The authors believe that the round type of grain was most widely distributed for over one thousand years from a period prior to the 11th century and continued to prevail through the 18th century. In the interim report mentioned above, this type was designated as "*japonica*" but more precisely this should be called "*japonica-like*".⁵⁾ After the 18th century, this type became restricted to the northern and northeastern region and disappeared from the central region. One of the authors has reported elsewhere (Watabe: 1966) of the existence of a glutinous rice zone extending in the north

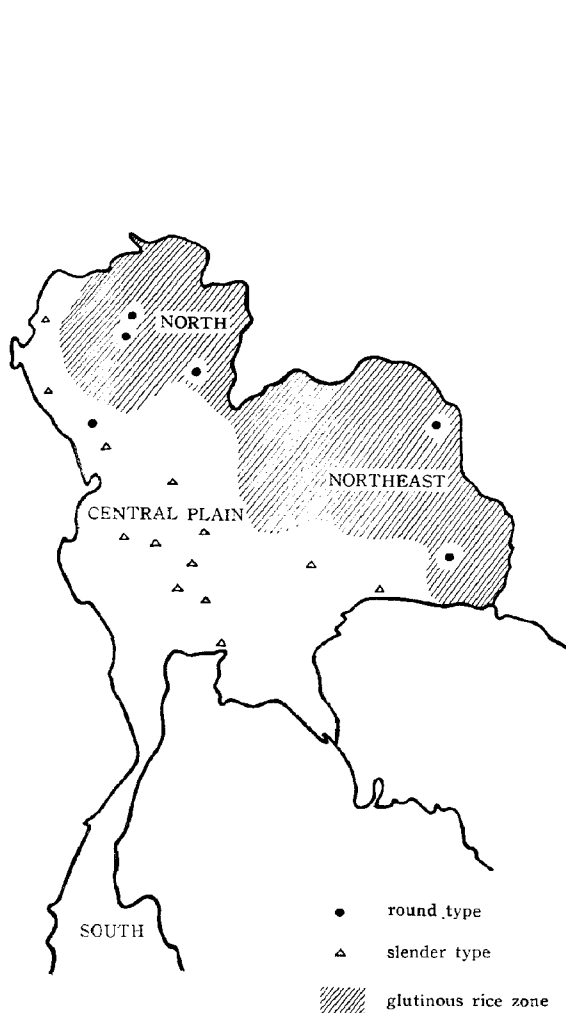


Fig. 3 Distribution of round and slender types after 18th century and glutinous rice zone in Thailand

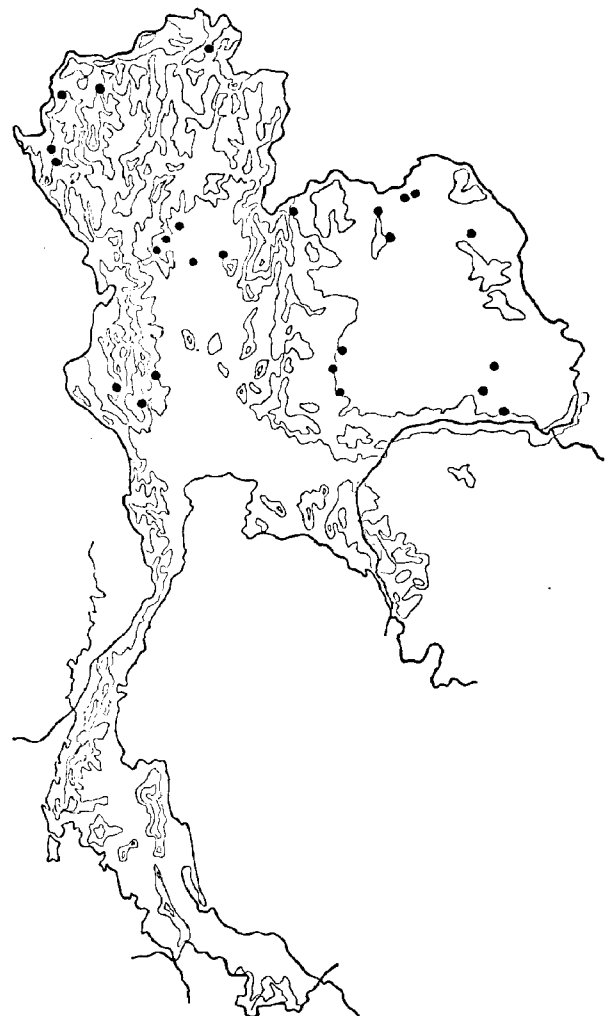


Fig. 4 Distribution of large type over contour-line map

5) Morinaga (1969) pointed out that in Southeast Asia there are such ecotypes as identical with *japonica* in shape but different in characteristics.

and northeastern parts of Thailand. It is to be noted in this connection that the distribution of the round type of grain after the 18th century is only limited to such areas where irrigation water is comparatively available (Fig. 3). It is not unlikely that this type belongs to the glutinous-lowland variety.

Until the 15th century, the large type of rice seems to have been dominant in most of the present day boundary of Thailand. It decreased gradually, however, to such an extent that in the period after the 15th century it was almost extinct in the Central Plain. If we superpose the distribution of this type of grain over a contour-line map of the Kingdom, it will be seen that the sampling sites are located on mountain or plateau areas regardless of the estimated age of the grain (Fig. 4). Careful examination will reveal another fact that the later the date, the higher and remoter the region of distribution. It may therefore be inferred that the large type of grain is of the upland variety. Not a few investigations conducted so far reveal that glutinous varieties are occupying the greater part of upland rice production in the northern border areas of Thailand. Thus most of these large type varieties are presumably of the glutinous-upland variety.⁶⁾

As for the slender type variety, it is restricted to Cambodia and part of northeastern Thailand adjacent to Cambodia at a period prior to the 11th century. This type expanded later so that in the 15th–18th centuries, at least in central Thailand, it became as prevalent as the round type and from the 18th century onward, it became dominant in central Thailand. With a clear contrast to the round type, the distribution of the slender type prevails outside the glutinous rice zone mentioned above, namely, it is restricted to the present-day non-glutinous lowland rice cultivating area (Fig. 3). This result shows that most of these slender type varieties are probably of the non-glutinous lowland variety.

III Concluding Remark: Reasons for the Alteration

So far as the Central Plain or the Mae Nam Chao Phraya basin is concerned, the alteration of cultivated rice since the 6th century may be described as follows: in the beginning, two types were dominant, a glutinous lowland round type variety and a glutinous upland large type variety. Gradually the latter upland variety decreased and a third, lowland slender type variety began to increase, till at last this third type replaced the two former types. Hence, the dominancy of the non-glutinous lowland variety in this region.

Which came to be cultivated first, the glutinous lowland variety or the glutinous upland variety? Based upon our knowledge of the general tendency in the development of rice-cultivation, it is safe to think that the upland variety was cultivated prior to the

6) Cho (1960), however, observed that some upland rice in Northern Thailand are, though very rarely, of round type.

lowland variety. Therefore, the equal distribution, during the 6th-11th century for example (see Fig. 2), of the round type, which most probably represents a glutinous lowland variety, and the large type, which is supposed to be a glutinous upland variety, shows the co-existence at that time of a remnant of an older farming culture, on the one hand, and principal food crop of more recent farming culture, on the other. We can thus suppose, in conclusion, that in the Central Plain of Thailand, the alteration of the dominant varieties, began with the existence of the glutinous upland variety, then changed to the glutinous lowland variety and at last the non-glutinous lowland variety. In the north and a part of the northeast, the present situation represents a stage in which the glutinous upland variety was replaced by the glutinous lowland variety. This explains the existence of the glutinous rice zone. As for Cambodia, the available data is too limited for us to reconstruct any meaningful sequence of alteration of rice varieties. It may be useful in this connection to conduct a similar survey for the early Funnanese Oc-Eo and Chenla, especially the Land Chenla areas. Our premature guess is that throughout the Angkorian period (9th-15th centuries) the dominant variety in Cambodia was of the slender type. Such a situation is quite distinct from that in Thailand.

Since these alterations took place in the relatively short span of 1,000 years or more, it would be wrong to attribute them to a botanical evolution. The reason must be sought in a complex alteration of ethnic groups in the region. Population growth might have necessitated a search for varieties with a higher productivity. As for the acute increase of the slender type in the Central region, the introduction of commercialized rice farming to cope with the growing demand of rice for export after the coming into force of the Bowring Treaty in 1855, as was pointed out in the interim report.

Acknowledgements

We wish to express our deep thanks to the Government of Thailand, especially the National Research Council, the Fine Arts Department and the Rice Department without whose generous assistance the present research could not be carried out. Our gratitude also goes to Dr. Shinobu Iwamura, Professor Emeritus of Kyoto University and former director of the Center for Southeast Asian Studies who has given us advice and encouragement. Through useful discussion Professors Yoneo Ishii and Yoshikazu Takaya helped us greatly. And last but not least, a word of appreciation should be accorded to Mr. Susumu Sakaguchi, former botanist of Centre Technique Agricole de l'Amitié Khméro-Japonaise, Cambodge, who rendered valuable assistance in varieties of way.

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Appendix: Main Characters of Old Grains

No.	Sampling Site (province)	Estimated age (century A.D.)	Grain shape			Grain type**
			length (mm)	breadth (mm)	length/ breadth	
T 67-01	Nakhon Sawan	6-11	7.91±0.91	3.51±0.11	2.25±0.09	L
T 67-02	do	6-11	7.28±0.28	3.41±0.15	2.13±0.10	R L
T 67-03	do	13-14	7.45±0.25	3.33±0.18	2.24±0.13	R
T 67-04	Kamphaeng Phet	14	6.73±0.55	2.90±0.10	2.32±0.13	R
T 67-05	do	14	7.01±0.17	2.90±0.13	2.42±0.08	R
T 67-06	Nakhon Sawan	6-11	7.36±0.37	3.31±0.20	2.22±0.04	R L
T 67-07	Uttaradit	6-11	6.70	2.90	2.31	R
T 67-08	Sukhothai	14	7.29±0.58	3.07±0.18	2.37±0.18	R L S
T 67-09	do	14	7.01±0.13	2.99±0.11	2.34±0.09	R
T 67-10	do	14	—	—	—	—
T 67-11	do	14	7.31±0.44	3.01±0.22	2.43±0.21	R S
T 67-12	do	13-15	7.41±0.67	3.06±0.28	2.42±0.10	R L S
T 67-13	do	13-15	7.01±0.12	2.95±0.06	2.38±0.07	R
T 67-14	do	13-15	7.15±0.24	3.03±0.16	2.36±0.19	R S
T 67-15	Lop Buri	17	7.10±0.30	3.06±0.26	2.32±0.16	R
T 67-16	do	17	6.94±0.16	3.23±0.16	2.15±0.10	R
T 67-17	Ayutthaya	14-18	7.50±0.38	3.13±0.17	2.40±0.09	R S
T 67-18	do	14-18	7.06±0.22	3.13±0.25	2.26±0.18	R
T 68-01	Samut Prakan	19	7.61±0.26	2.81±0.25	2.67±0.24	S
T 68-02	Ayutthaya	19	7.94±0.48	2.51±0.83	2.90±0.19	S
T 68-03	do	16-18*	7.43±0.32	3.15±0.24	2.39±0.16	S
T 68-04	do	15	7.95±0.35	3.17±0.22	2.51±0.16	S
T 68-05	do	16	7.28±0.44	3.10±0.18	2.31±0.22	R S
T 68-06	do	14-15	7.55±0.47	3.09±0.20	2.46±0.17	R S
T 68-07	Ang Thong	19	7.97±0.74	3.11±0.28	2.68±0.29	S
T 68-08	do	19	8.05±0.36	2.86±0.20	2.91±0.18	S
T 68-09	Lop Buri	19	8.17±0.62	3.21±0.15	2.66±0.05	S
T 68-10	Uthai Thani	19	8.33±0.51	2.86±0.20	3.22±0.26	S
T 68-11	Nakhon Sawan	9	7.62±0.35	3.53±0.16	2.15±0.10	R L
T 68-12	do	13	7.60±0.67	2.97±0.17	2.51±0.23	R

No.	Sampling Site (province)	Estimated age (century A.D.)	Grain shape			Grain type**
			length (mm)	breadth (mm)	length/ breadth	
T 68-13	Nakhon Sawan	18	7.05±0.32	3.10±0.10	2.32±0.05	R
T 68-14	Chon Buri	19	8.28±0.20	3.17±0.04	2.63±0.09	S
T 68-15	Nakhon Pathom	9-11*	6.35±0.36	2.89±0.18	2.19±0.15	R
T 68-16	Suphan Buri	14	7.35±0.41	3.16±0.21	2.29±0.18	R L S
T 68-17	do	14	6.81±0.40	3.10±0.22	2.21±0.24	R
T 68-18	do	14	7.36±0.35	3.28±0.16	2.24±0.12	R
T 68-19	do	6-11	6.73±0.38	3.14±0.17	2.14±0.12	R
T 68-20	do	6-11	7.40±0.36	3.25±0.20	2.27±0.12	R L S
T 68-21	Saraburi	17-18	7.46±0.31	3.02±0.27	2.36±0.18	S
T 68-22	Lop Buri	17	7.76±0.44	2.88±0.16	2.57±0.21	S
T 68-23	do	14-17	7.92±0.34	3.17±0.16	2.51±0.23	S
T 68-25	Kamphaeng Phet	14	6.90±0.21	3.06±0.23	2.32±0.01	R
T 68-26	do	14	6.57±0.33	3.37±0.21	1.95±0.15	R
T 68-28	do	14	7.06±0.23	2.94±0.14	2.39±0.13	R S
T 68-29	Lampang	before 10	7.40±0.00	3.10±0.15	2.39±0.15	R
T 68-30	Chiang Mai	13	7.33±0.42	3.21±0.23	2.26±0.21	R L
T 68-31	do	14	7.22±0.36	3.11±0.23	2.32±0.17	R S
T 68-32	do	14-16	7.10±0.23	3.17±0.44	2.38±0.29	R
T 68-33	do	14-16	7.20±0.13	3.12±0.13	2.38±0.07	R
T 68-34	do	16	7.78±0.24	3.22±0.20	2.26±0.09	R S
T 68-35	Mae Hong Son	19	8.05±0.50	3.27±0.21	2.45±0.28	L S
T 68-36	do	17-19*	8.22±0.42	3.05±0.21	2.68±0.23	L S
T 68-37	do	19	9.25±0.66	3.62±0.25	2.53±0.14	L
T 68-39	Chiang Rai	13	7.65±0.46	3.20±0.25	2.37±0.15	R S
T 68-40	do	12-14*	7.95±0.75	3.14±0.12	2.38±0.44	R
T 68-41	Chiang Mai	13	7.43±0.60	3.43±0.12	2.17±0.24	R
T 68-43	do	19	—	—	—	—
T 68-44	Lamphun	16	7.30±0.38	3.01±0.11	2.42±0.11	R S
T 68-45	do	19	7.56±0.24	3.35±0.26	2.14±0.11	R
T 68-46	do	15	6.85±0.05	2.93±0.17	2.37±0.14	R
T 68-47	Sukhothai	13-14	6.33	2.95	2.14	R
T 68-48	do	13-14	7.18±0.49	3.15±0.23	2.28±0.24	R
T 68-49	Uttaradit	12	7.83±0.41	3.09±0.16	2.53±0.20	S
T 68-50	do	11-13	7.01±0.31	3.00±0.17	2.33±0.14	R
T 68-52	Sukhothai	19	7.74±0.75	2.97±0.17	2.50±0.27	S
T 68-53	Tak	19	7.48±0.48	3.16±0.16	2.30±0.18	R S
T 68-54	Sing Buri	16	7.86±0.58	3.12±0.18	2.53±0.24	S
T 68-55	Saraburi	16	7.26±0.42	2.88±0.19	2.52±0.21	R S
T 68-57	Kanchanaburi	15-17	7.41±0.63	3.13±0.20	2.31±0.20	R L S
T 68-58	do	16-18*	7.39±0.42	3.13±0.19	2.37±0.24	R S
T 68-59	Phetchaburi	16-18	7.82±0.45	2.80±0.17	2.81±0.30	S
T 68-60	Nakhon Ratchasima	17	7.95±0.57	3.19±0.20	2.51±0.15	L S
T 68-61	do	19	8.03±0.50	3.20±0.15	2.53±0.18	L S
T 68-62	do	12	7.76±0.61	3.33±0.17	2.34±0.16	R S L

No.	Sampling Site (province)	Estimated age (century A.D.)	Grain shape			Grain type**
			length (mm)	breadth (mm)	length/ breadth	
T 68-63	Nakhon Ratchasima	12	7.22 ± 0.33	3.30 ± 0.17	2.19 ± 0.13	R
T 68-64	Buri Ram	11	—	—	—	—
T 68-65	Surin	18	7.40 ± 0.24	2.88 ± 0.14	2.73 ± 0.17	S
T 68-67	do	19	7.45 ± 0.59	3.01 ± 0.25	2.48 ± 0.21	R L S
T 68-68	Roi Et	12-15	8.77 ± 0.69	3.62 ± 0.30	2.47 ± 0.22	L
T 68-69	Kalasin	9-11*	7.38 ± 0.55	3.20 ± 0.14	2.30 ± 0.20	R S
T 68-70	Udon Thani	6-11	8.45 ± 0.63	3.42 ± 0.23	2.48 ± 0.22	L S
T 68-71	Loei	18	7.92 ± 0.63	3.39 ± 0.23	2.33 ± 0.23	R L
T 68-72	Udon Thani	14-15	7.66 ± 0.55	3.36 ± 0.16	2.31 ± 0.18	R L S
T 68-73	Nong Khai	11-14	8.40 ± 0.68	3.32 ± 0.22	2.53 ± 0.22	L S
T 68-74	do	16-17	7.95 ± 0.33	3.27 ± 0.22	2.45 ± 0.09	L S
T 68-75	Sakon Nakhon	11-14	8.40 ± 0.23	3.53 ± 0.11	2.37 ± 0.11	L
T 68-76	Nakhon Phanom	19	7.40	3.40	2.00	R
T 68-77	Ubon Ratchathani	6-11	7.95 ± 0.64	3.51 ± 1.05	2.26 ± 0.19	R L S
T 68-78	Prachin Buri	18	7.62 ± 0.47	2.99 ± 0.19	2.58 ± 0.21	S
T 68-79	Phetchaburi	14-18*	7.42 ± 0.22	3.08 ± 0.18	2.38 ± 0.13	S
T 68-80	Phuket	14-18	—	—	—	—
T 68-81	Nakhon Si Thammarat	13	7.01 ± 0.57	3.07 ± 0.13	2.34 ± 0.14	R S
T 68-82	Songkhla	13-14	6.55 ± 0.33	3.20 ± 0.14	2.07 ± 0.10	R
T 68-83	Pattani	10	—	—	—	—
T 68-84	do	18-19	—	—	—	—
T 68-85	Phatthalung	13-15	—	—	—	—
C 69-01	Battambang	13-14	7.92 ± 1.76	2.48 ± 0.62	3.20 ± 0.69	S
C 69-02	Siemreap	10	—	—	—	—
C 69-03	do	10-12	—	—	—	—
C 69-032	do	12	—	—	—	—
C 69-033	do	10	—	—	—	—
C 69-034	do	10	—	—	—	—
C 69-04	do	9	—	—	—	—
C 69-05	do	9	7.20 ± 1.40	2.42 ± 0.81	2.98 ± 0.48	S

* dated by ^{14}C analysis.

** R : round type, L : large type, S : slender type